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Guidelines for Sewage Sludge Utilization on Agricultural Lands

**PREPARED BY THE
SLUDGE AND WASTE UTILIZATION COMMITTEE
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Ministry
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Ministry
of the
Environment



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Development of Guidelines for Sewage Sludge Utilization on Agricultural Lands commenced in 1970. Since then many agencies and organizations have contributed to these Guidelines. The sponsoring Ontario Ministries, Agriculture and Food, and Environment, wish to acknowledge the advice and assistance provided by:

The Ontario Ministry of Health
The Department of Land Resource Science, University of Guelph
The Ontario Federation of Agriculture
The Ontario Municipal Liaison Committee
The Ontario Soil and Crop Improvement Association
The Association of Local Official Health Agencies
Environment Canada
Agriculture Canada



FOREWORD

These Guidelines are supported by research, ongoing since 1971, which is addressing concerns such as the potential impacts of sludge spreading practices on human and animal health, land productivity and the environment. Limits were established, in 1978, to control the concentrations of 11 heavy metals in sludges being applied to foodland. The application rates quoted herein for ammonium plus nitrate nitrogen, provide a measure of the plant-available nitrogen in the year of sludge application. Controls, on metals and nitrogen, enable agriculture to benefit from sewage sludge utilization.

The Guidelines were originally approved for implementation by the Ontario Cabinet in July, 1979. Between 1979 and 1982, a phase-in period enabled municipalities, with sludges not meeting the criteria, to improve the quality of their sludges or to develop acceptable disposal alternatives. Changes, in 1986, included new criteria for the acceptability of aerobic, dewatered and dried sludges. Statements of the rights and responsibilities of sewage treatment plant operators, sludge haulers and farmers were added. Adjustments were made to separation distances and waiting periods. In addition, sludge blending criteria and a statement of the need for contingency planning by sewage treatment plant operators, were included.

In this edition, the principle change is a relaxation of some separation distances in Section 5.0. In addition, the Tables have been reformatted, to separate sludge and soil criteria. Minor errata have been corrected. Additional emphasis has been placed on previous recommendations that sludge use is not recommended for tobacco or vegetable production or for use on home gardens.

The Sludge and Waste Utilization Committee, which includes representation from the Ministries of Agriculture and Food, Environment, and Health, as well as from the Wastewater Technology Centre, Brock University, the University of Guelph, the Municipal Engineers Association, the Association of Local Official Health Agencies, sludge haulers and the Ontario Federation of Agriculture, oversees interpretation, implementation and review of the Guidelines.

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1.1 Purpose, Objective and Scope

a. Purpose

The purpose of these Guidelines is to facilitate the recycling and use of sewage sludge on land, while protecting the quality of food, the health of consumers and the quality of the environment. The Guidelines supplement Ontario Regulation 309, made under the *Environmental Protection Act*.

b. Objective

The objective of these Guidelines is to ensure that, when sewage sludge is applied to land, the nitrogen, phosphorus, organic matter and micronutrients it contains will benefit crops without degrading the environment or risking the health and productivity of the crops, animals and people of Ontario.

c. Scope

These Guidelines refer to municipal sewage sludge, as included under "processed organic waste" in Ontario Regulation 309, which was made under the *Environmental Protection Act*. They do not refer to "hailed sewage" (i.e., wastes removed from cesspools, septic tank systems, privy vaults, privy pits, chemical toilets, portable toilets and sewage holding tanks) to other unstabilized wastes, or to other organic wastes.

1.2 Sludge, Soil and Crop Monitoring

The Ministry of the Environment monitors nitrogen, phosphorus, total solids and eleven heavy metals in sewage sludge. The Ministry of Agriculture and Food records the background concentrations of metals in soils, crops, animal feed and animal products. In co-operation with the Ministry of the Environment, it also routinely determines certain metal concentrations in soils, to verify the acceptability of sludge application sites. The areas sampled include those in which naturally-occurring metal concentrations may be expected to be high and fields to which municipal sewage sludge has been applied for extended periods.

In addition, before the Ministry of the Environment issues Certificates of Approval for sludge application, it verifies that the results of soils analyses, conducted within the previous three years, demonstrate that soil pH and soil phosphorus concentrations are acceptable.

1.3 Value of Sewage Sludge

Sewage sludge is a valuable replacement for nitrogen and phosphorus fertilizers. It also supplies other nutrients, such as magnesium, zinc, copper and boron. The organic matter in sewage sludge improves soil structure.

2.0

CRITERIA RELATING TO SEWAGE SLUDGE PROCESSING

All sewage sludges must be stabilized before being spread on land. This reduces their odour potential and the number of pathogenic organisms they contain.

Proper anaerobic and aerobic digestion processes provide appropriate stabilization. Other stabilization methods are discussed in the Ministry of the Environment's "Guidelines to Govern the Stabilization and/or Dewatering of Municipal Sewage Sludge Prior to Its Utilization/ Disposal". Case-by-case judgment on the acceptability of these other methods is usually necessary.

3.0

CRITERIA RELATING TO NITROGEN AND PHOSPHORUS

Before sludge is applied, the farmer should be advised of ammonium plus nitrate nitrogen and phosphorous concentrations, so that sludge and fertilizer rates may be adjusted.

3.1 Available Nitrogen

Nitrogen is usually the most valuable agricultural constituent in fluid anaerobically digested sewage sludges. These sludges normally contain 0.1 to 0.3% total nitrogen, of which 25% to 50% is in the ammonium form. Aerobic and dewatered sewage sludges usually contain appreciably less total nitrogen; less than 25% is in the ammonium and/or nitrate form. The ammonium plus nitrate nitrogen present in sewage sludge provides an approximate measure of the nitrogen immediately available for crop use. Unless the sludge is immediately incorporated into the soil, up to 50% of its ammonium nitrogen can be lost by volatilization. Conversion by soil micro-organisms, of organic nitrogen in the sludge to ammonium and nitrate nitrogen, may compensate for this volatilization loss.

3.2 Nitrogen Application Rates

3.2.1

Types of Crop

- a. Application rates for sewage sludge are based on the nitrogen fertilizer recommendation for the crop, as described in the OMAF Publications 296 (Field Crop Recommendations) and 360 (Fruit Production Recommendations), which are revised annually.

- b. Although many crops benefit from annual nitrogen applications, the sludge application rate should not exceed 135kg of ammonium plus nitrate nitrogen per hectare, over a five year period, or over a four year period for commercial sod.

The intent of this requirement is to control the rate of accumulation of phosphorus and metals in the soil and to provide for their wider distribution and efficient use by crops.

- c. The suitability of crops to receive sewage sludge is discussed in Tables 1 and 2. In addition, Table 1 provides criteria for sludge application rates and time of application. Corn for grain or silage, grass for hay or pasture, and commercial sod, which require substantial amounts of nitrogen, are best suited to use sewage sludge nitrogen. If care is taken in the rate and time of application, sewage sludge can be applied to cereals, which require less nitrogen, and to other crops, including legumes such as alfalfa, trefoil and soybeans, which require little or no nitrogen. The quantity applied, in any one growing season, should be based on:

- ammonium plus nitrate nitrogen content and
- the nitrogen fertilizer recommendation for the crop (see OMAF Publications 296 and 360). Legumes are an exception in that the allowable sludge application rates may provide more nitrogen than is recommended, without crop damage or impairment of groundwater quality. In no case may the nitrogen application rate exceed that specified in Section 3.2.1b above.

3.2.2

Time of Application

Sewage sludge is most effective as a nitrogen source when applied in spring. Late summer and fall applications are permitted, but subsequent nitrogen losses by leaching and denitrification will usually be greater than when the sludge is spring applied. Nitrogen, applied in late summer and fall, is about 50% as available to crops as that in spring applications. The rates of sludge applications in late summer and fall can be increased proportionally. Exceptions are grass and commercial sod, which can use appreciable amounts of nitrogen in the fall.

In no case may the nitrogen application exceed that specified in Section 3.2.1b. Criteria for specific crops are shown in Tables 1 and 2.

3.3 Nitrogen Analyses

Analyses, to determine the ammonium plus nitrate nitrogen concentrations in sludge must be performed regularly. The frequency of these analyses should permit the estimation of this nitrogen concentration within 25% of the actual concentration.

3.4 Phosphorus

The acid soluble phosphorus content of the sludge should be determined. This phosphorus is approximately 40% as available to plants as fertilizer phosphorus. Sewage sludge is a rich source of plant-available phosphorus.

4.0

CRITERIA RELATING TO CONTAMINANTS

4.1 Metals, of Concern to Agriculture, in Sludge

The metals in sewage sludges of concern to agriculture are arsenic, cadmium, cobalt, chromium, copper, mercury, molybdenum, nickel, lead, selenium and zinc. Data and criteria for these metals are shown in Tables 3 and 4. In addition, a synopsis of background information is presented in Appendix II.

4.1.1

Acceptability Criteria and Spreading Rates

Only sludges with low metal concentrations are suitable for use on land. Analyses must be provided to show that the sludges used conform with the criteria defined below.

a. Anaerobically Digested Sludges

The nitrogen to metal ratios, as shown in Table 4, column 2, relate ammonium plus nitrate nitrogen concentrations to acceptable metal concentrations. The averages of ammonium plus nitrate nitrogen concentrations in the sludge during the preceding 12 months are divided by the average of metal concentrations during the same period. Alternatively, at the discretion of local MOE staff, the average of the ammonium plus nitrate nitrogen concentrations during the previous 3 months may be divided by the average of metals concentrations during the same period. Sludges, with ratios equal to or greater than those in column 2, are suitable for use on land; those with lower ratios are judged unsuitable.

Sludge application rates are based on the concentrations of plant-available nitrogen i.e. ammonium plus nitrate nitrogen. The nitrogen application rate should not exceed that specified in Sections 3.2.1b and c.

b. Aerobically Digested and Other Stabilized Aerobic Sludges

Ontario studies have shown that these sludges have low ammonium plus nitrate nitrogen concentrations and do not normally meet the nitrogen to metal ratios required for anaerobic sludges (Table 4, column 2). However, they contain substantial amounts of phosphorus, micronutrients and organic matter; which are valuable to agriculture.

For land application, the metal concentrations in aerobic sludges should not exceed those specified in Table 4, column 4. The averages of metal concentrations in the sludge during the preceding 12 months are divided by the average total solids concentrations during the same period. Alternatively, at the discretion of local MOE staff, the average of the last 3 metals analyses may be divided by the average of total solids concentrations during the same period may be used. Sludges, with concentrations equal to or less than those in Table 4, column 4 are suitable for use on land; those with higher ratios are judged unsuitable.

Aerobic sludges may be applied at rates up to 8 tonnes of solids per hectare per five years. The nitrogen application rate should not exceed that specified in Section 3.2.1b and c.

c. Dewatered and Dried Sludges

These sludges contain substantial amounts of phosphorus, organic nitrogen, micronutrients and organic matter, which are valuable to agriculture. However, there are substantial losses of plant-available nitrogen when sewage sludges are dewatered or dried. For this reason, fluid sludge is preferable to dewatered or dried sludge for use on land.

All dried and dewatered sludge used on land must conform with Table 4, column 4. Anaerobically digested sludges used on land must, prior to dewatering or drying, also conform with the criteria in column 2.

Dewatered and dried sludges may be applied at rates up to 8 tonnes of solids per hectare per 5 years. The nitrogen application rate should not exceed that specified in Sections 3.2.1b and c.

The farmer must be advised of ammonium plus nitrate nitrogen and phosphorus concentrations in dried or dewatered sludge, so that he can adjust sludge and fertilizer applications accordingly.

d. Composted Sludges

Guidelines for composting sewage sludge are being developed. In the meantime, enquiries should be directed to MOE Regional or District Offices.

4.1.2

Marginally Acceptable Sludges

A marginally acceptable sludge is one which fails to meet the acceptability criteria for metals (Table 4, column 2 or 4), but which is within 10% of those criteria. Such sludges can be applied on a temporary basis. Application rates must then be proportionally reduced. If, after repeated sampling, those sludges do not meet the acceptable metals criteria, action must be taken to make them acceptable. Alternatively they must be disposed of by means other than utilization.

4.2 A Program to Limit Metal Accumulation in Soils

Only anaerobically digested sewage sludges with ammonium plus nitrate nitrogen to metal ratios equal to or greater than those in Table 4, column 2, or aerobic sludges with metal concentrations no greater than those in column 4 may be used on land on an on-going basis.

The application of a sewage sludge complying with these Guidelines could elevate the metal concentrations of a typical Ontario soil to the maximum limits recommended within 25 to 55 years. If metal concentrations in sludges are further reduced, sludge application can continue for a longer period of time. For example, if the nitrogen to metal ratios for an anaerobic sludge are no greater than those in Table 4, column 3 or if the metals to solids ratios are no greater than those in column 5, its application to the same area of land can continue for at least 250 years.

4.3 Industrial Organic Contaminants

There are significant gaps in knowledge, with respect to the fate of organic contaminants in sewage sludges applied to land. However, there is no evidence at present that they pose a risk to human health.

Research programs are being undertaken in Canada and the United States to improve methods for determining the nature, extent, fate and effects of toxic organic compounds in the environment.

5.0

CRITERIA RELATING TO SPREADING SITES

Under the Environmental Protection Act, all sludge spreading sites must be certified by the Ministry of the Environment. Prior to certification and sludge application, the site location, land and soil characteristics and proposed site management methods must be assessed with a view to minimizing the potential contamination of surface watercourses, groundwater, wells and residences.

5.1 Separation Distances

The separation distances required for sludge spreading operations are provided in Table 5 and 6. More detailed information about separation distances is provided below.

Regional staff who issue Approvals may specify lesser separation distances. However, they will do so only following careful consideration of the proposals received, the information provided below and consultations with Conservation Authorities and nearby residents. Reduced separation distances will be specified in Conditions attached to Certificates of Approval issued pursuant to the *Environmental Protection Act*.

5.1.1

Surface Watercourses

For the purposes of these Guidelines, a surface watercourse is defined as a natural or established surface watercourse or an open municipal drain along which water flows on a continuous or intermittent basis. Points of direct access (such as catch-basins for drainage tiles or municipal drains) should be treated as watercourses for separation distance purposes.

The minimum distance between the spreading site and a surface watercourse is normally determined from Table 5, which takes into account land slope and soil permeability. However, when the sludge is not spread by irrigation, it may be applied more closely to surface watercourses than is indicated in the Table, for example when:

- a. The sludge is injected directly into the soil;
- b. The sludge is spread by surface irrigation and is disced or ploughed in when dry and before 24 hours have elapsed;
- c. The soils on which the sludge is to be spread are described in soil survey reports as "well drained";
- d. Crop residues are present which will prevent or inhibit precipitation from washing sewage sludge residues into watercourses;
- e. Soil tillage, sludge application and/or cropping follow land contours;
- f. Other factors, as may be determined locally, inhibit or prevent transfer of sewage sludge residues into watercourses.

However, sewage sludge should not be applied within 10 metres of any watercourse or body of water.

Ministry of the Environment staff will advise on separation distances from bodies of water or drainage channels other than surface watercourses as defined above.

Additional information is provided in Section 5.2.6.

5.1.2

Groundwater

The ground water table should not be within 0.9 metres of the soil surface at the time of sewage sludge application.

5.1.3

Bedrock

Sewage sludge application should not normally be allowed where the soil overlying bedrock is less than 1.5 metres thick.

5.1.4

Residences

When sludge is applied to land in the proximity of residences, concerns may arise due to the potential for odours, air-borne drift of sludge particles and surface run-off. The extent of these concerns will depend upon the sludge application method and land slope. The minimum distances between the spreading site and a residence in a residential area and an individual residence not in a residential area are normally 450 metres and 90 metres, respectively. However, when the sludge is injected directly into the soil, or when it is spread by surface irrigation and is disced after it has dried and before 24 hours have elapsed, these distances may be reduced. The extent to which they may be reduced depends upon the local situation. In addition, the distances may, at the discretion of the farmer, be reduced when the farmer is the owner and occupier of the individual residence.

However, sludge shall not be applied closer than 50 metres to a residence in a residential area or closer than 25 metres to a residence not in a residential area.

5.1.5

Water Wells

The minimum separation distance between the spreading sites and water wells shall be 15 metres for drilled wells more than 15 metres deep and 90 metres for all other wells, including dug wells.

5.2 Soil Criteria

5.2.1

Organic Soils

Sewage sludge may be applied to 'mineral' soils but not to 'organic' soils. 'Organic' soils are defined as soils which contain 17% or more of organic carbon by weight and which have a depth of 0.4 metres or more of unconsolidated organic material. Soils which do not meet these specifications are termed 'mineral'.

5.2.2

Metals

Sewage sludge may not be applied to soils whose metal concentrations are equal to or greater than those in Table 3, column 3.

5.2.3

Phosphorus

Sludges may not be applied to soils containing more than 60 milligrams of sodium bicarbonate extractable phosphorus per litre in the top 15 centimetres.

5.2.4

Soil pH

Most metals are more soluble and are hence more available to plants in acid soils than in neutral or calcareous soils. Thus, sewage sludge should not be applied to soils with pH values of less than 6.0. However, sludges containing lime may be applied to soils of lower pH, when they will raise the soil pH to at least 6.0. Soil pH may also be raised by the addition of agricultural lime.

5.2.5

Soils Tests

Certificates of Approval will not be issued, nor will sludge spreading be permitted, unless satisfactory analyses for phosphorus and soil pH are available from soil samples taken within three years.

5.2.6

Snow Covered and Frozen Ground

To minimize runoff, sludges should not be spread on frozen or ice covered soil. Sludge spreading is acceptable when there is little or no frost in the soil and the surface is snow-covered. For fields having a sustained slope of not more than 3%, spreading may be allowed on frozen soil, provided that the risks of runoff have been determined to be minimal. In such cases, the separation distances from surface water courses noted in Table 5 should be doubled. Where surface run-off is expected as a result of snow-melt, a more critical evaluation of the site will be required.

5.3 Eliminating Runoff and Reducing Soil Compaction

Soil tillage and sewage sludge application should, where possible, follow the contours of the land. Traffic by sewage sludge spreading vehicles should be minimized to reduce soil compaction.

Sewage sludge is best applied to unploughed soil when the residues of the previous crop are present to help control runoff, particularly when sludge is applied during the winter.

5.4 Waiting Periods After Spreading

Following sludge application, waiting periods in accordance with Table 1 are necessary. These waiting periods are required because, even after stabilization, sewage sludge contains some pathogenic organisms.

6.0

SLUDGE HANDLING AND SPREADING

6.1 Sludge Application

The maximum depth of fluid sludge which may be spread at any one time is 1.3 cm. There may be no subsequent application until the preceding application has dried. Criteria for maximum application rates are provided in Sections 3.0 and 4.0.

Uniform spreading of sludge is essential to ensure that each part of the field receives the same rates of sludge nutrients and metals. Spreading vehicles should have calibrated equipment which can be relied on to control the rate of sludge application. Unsealed tanks, for which gravity flow and ground speed are the only means of adjusting spreading rates, will not spread sludge uniformly.

Sewage sludge should not be spread if the vehicle would cause undue compaction or damage soil structure. Spreading vehicles with flotation tires are preferred. Even flotation tires can cause serious soil compaction when the soil is wet.

The overall quality of spreading is a major factor affecting the willingness of farmers to continue using sewage sludge.

6.2 Storage and Blending

6.2.1

Requirements for Storage

A Certificate of Approval is required for a sludge storage facility. Sludge storage may be required during inclement weather and during the required waiting periods between spreading and cropping or pasturing. Sufficient storage must be available to retain sludge during these periods. It is anticipated that a minimum time of 6 months of storage will normally be found necessary.

In Ontario, earthen lagoons are generally used for sludge storage or blending, but other facilities are also used. Sludge must meet the Guidelines' criteria when it is spread on land. Therefore, it must be well-mixed, so that it is of uniform quality before it is withdrawn from storage.

6.2.2

Sludge Blending

Sludge storage presents an opportunity for blending. Two or more sludges with unacceptable nitrogen to metal ratios or metals content may, after blending, form an acceptable sludge mixture. In such circumstances, proper mixing is essential. Periodic verification, that sludge taken from the blending facility is uniform and meets the guidelines' criteria, is required.

6.2.3

Sludge-Manure Blending

The blending of acceptable sewage sludge and liquid livestock manure is acceptable, provided adequate storage and land for spreading are available. The spreading rate should be related to the nitrogen requirement of the crop. Not more than 1.3 cm depth of the blended material may be applied at any one time. The total amount of sludge applied per 5 years must not exceed that specified in Section 3.2.1b or Section 4.1.1b. It is the farmer's responsibility to spread blended sludge in accordance with the Guidelines.

6.3 Responsibilities and Rights

Some of the responsibilities and rights of those involved in sludge utilization are outlined below.

6.3.1

Operating Agencies

The responsibilities of agencies operating sewage treatment plants are set out below.

a. Record-keeping

Records are to be kept of:

- The location of all fields receiving sewage sludge;
- The amount of sewage sludge applied to each field; and
- Sludge analyses.

A report, similar to that shown in Appendix I, is to be provided to the sludge hauler. The report shall include data on the sludge's average nutrient content per cubic metre.

The farmer shall, on request, be advised of the annual average quantities of metals per cubic metre of sludge.

b. Sample Submission

The number of sewage sludge samples analyzed must be sufficient to establish representative values for all pertinent parameters. Sampling frequency is subject to approval by MOE Regional staff.

c. Monitoring Application Rates

Steps should be taken to verify that the sewage sludge application rates conform with those specified by Certificates of Approval.

d. Contingency Planning

Sewage treatment plant operating authorities are required to prepare contingency plans for situations where sewage sludge quality may temporarily fail to meet the requirements of these Guidelines. These situations may be the result of digester failure or of the need for digester cleanouts, and plant maintenance or expansion. These plans must provide for alternative methods for treatment and/or disposal.

Exemption from the Guidelines (see Section 7.0) will be considered only in unusual circumstances.

e. Marginal Sludges

Operating authorities will review the acceptability of their sludges immediately on receipt of analyses, to determine if measures to prevent sludges from becoming unacceptable, or corrective measures are needed.

Whenever marginal sludges are utilized on agricultural land, the farmer is to be advised of the deviations in sludge quality from the acceptable standards prescribed herein.

6.3.2

Sludge Haulers

The hauler must spread the sludge uniformly on land at the rate required by the farmer. (See Section 6.3.3.) The rates of actual nitrogen application rate (in kilograms per hectare) and/or sludge application (in cubic metres per hectare) must not exceed those specified in these guidelines or by the Ministry of the Environment.

The hauler must maintain all required separation distances and comply with other site requirements. Staking out distances from wells, watercourse and residences may facilitate satisfactory spreading.

The hauler must ensure that the farmer receives a report, similar to that shown in Appendix I, as soon as practicable after completing sludge application to any field.

The rights of the farmer must be respected with regard to timing and rate of application of sludge (see Section 6.3.3).

6.3.3

Farmers

The farmer, the sludge hauler and the sewage treatment plant operator should work together to develop a sludge utilization program for individual fields. The farmer has the right and the responsibility to insist on program flexibility, so that sludge application rates may be adjusted to suit the nitrogen and phosphorus requirements of the crop. In addition, the farmer may direct that sludge spreading operations be discontinued immediately.

The farmer also has the responsibility to see that appropriate waiting periods between sludge spreading and cropping or pasturing are observed. One should also seek advice from the intended markets as to other limitations or restrictions which may be applicable.

Farmers will receive a copy of a report, similar to that shown in Appendix I, to help them in their cropping programs.

7.0

EXEMPTION FROM THE GUIDELINES

When sludge quality deviates from the requirements of these Guidelines, sludge application to agricultural land may be considered, on an interim basis, but only in unusual circumstances. These unusual circumstances will not normally include situations which can be foreseen and for which contingency plans, as discussed in Section 6.3.1d, are to be developed.

Exemptions from the Guidelines will be considered on a case-by-case basis, through consultations between staff of the Ministry of the Environment and the Ministry of Agriculture and Food.

COMPLAINTS AND GUIDELINES INTERPRETATION

Questions on Guidelines' enforcement and their interpretation should be directed to:

- a.** OMAF local staff, when the questions relate to spreading methods, the need for supplemental fertilizers, crop quality, or animal health.
- b.** MOE local staff, when the questions relate to site approvals, sludge haulage, sludge quality or environmental issues.
- c.** The local Medical Officer of Health, when the questions relate to public health.

These agencies consult with one another as may be appropriate to ensure that agricultural, environmental and health considerations are taken into account. When necessary, these agencies also consult with the Sludge and Waste Utilization Committee.

Table 1:
SLUDGE SPREADING RESTRICTIONS
RELATED TO PUBLIC HEALTH AND PATHOGENS

Crop	Waiting Period After Application
Hay and Haylage	3 weeks before harvest
Pasture for horses, beef or dairy cattle	2 months before grazing
Pasture for swine, sheep or goats	6 months before grazing
Commercial Sod	12 months before harvest
Small fruits	15 months before harvest
Tree Fruits and grapes	3 months before harvest
Tobacco	Application not recommended
Home lawns and gardens	Application not recommended
Golf Courses and recreational land	Application recommended only if stabilization additional to digestion is used to reduce pathogenic content.

Table 2:
INFORMATION ABOUT SLUDGE APPLICATION FOR SPECIFIC CROPS

Crop	Comments
Field corn, hay, haylage, pasture, commercial sod	These crops are well-suited to using sewage sludge as a nitrogen source.
Cereals	Spring applications containing more nitrogen than is recommended for the crop may result in crop lodging. Fall application rates may be larger than those in Spring. See Section 3.2.2.
Perennial legumes and soybeans	Soybeans and hay-stands containing more than one-half legumes do not require added nitrogen. However, sewage sludge supplies phosphorus and organic material. Viable tomato seeds are contained in sewage sludges. These can pose a weed problem if soybeans or beans are to be grown.
Tree fruit and grapes	Sewage sludge may be applied in late fall (November) but earlier fall application can result in late release of nitrogen and hence cause poor fruit quality, delayed hardening of trees or vines and winter injury.
<p>Notes:</p> <ol style="list-style-type: none"> 1. The maximum application rate per hectare for anaerobically digested sludges is 135 kg of ammonium + nitrate nitrogen per 5 years (4 years for commercial sod); for aerobic, dewatered or dried sludges, application rate is 8 tonnes of solids per Hectare per 5 years. 2. No more than 1.3 cm depth (130 cubic metres per hectare) of fluid sewage sludge may be applied at any one time. 3. Nitrogen application rates for individual crops should not be exceeded. See OMAF publications 296, 360 and 362. 	

Table 3:
CRITERIA FOR METAL CONTENT IN SOILS

1	2	3	4	5
Metal	Mean Metal Content in Uncontaminated Ontario Soils ^a ug/g	Maximum Permissible Metal Content in Sludged Soils ^a ug/g	Maximum Permissible Metal Addition to Uncontaminated Soil ^b kg/ha	Minimum Number of years to reach Max. Recommended Metal Content in Soil based on the three previous columns ^{b,c}
ARSENIC	7	14	14	50
CADMIUM	0.8	1.6	1.6	30
COBALT	5	20	30	55
CHROMIUM	15	120	210	45
COPPER	25	100	150	55
MERCURY	0.1	0.5	0.8	45
MOLYBDENUM	2	4	4	25
NICKEL	16	32	32	45
LEAD	15	60	90	50
SELENIUM	0.4	1.6	2.4	45
ZINC	55	220	330	50

a. Based on dry weight at 100°C. The terms ug/g and mg/kg are interchangeable.

b. Columns 4 and 5 take into account the mean metal content of uncontaminated soils (see column 2). For most soils, adjustments to these numbers are needed because soils are unlikely to have exactly the mean metal contents listed in column 2.

c. Based on anaerobic sludge applications providing 135 kg of ammonium plus nitrate nitrogen, or aerobic sludge applications providing 8 Tonnes of dry solids per hectare per 5 years, with the ratios listed in Table 4 (columns 2 or 4). The number of years is rounded off to the nearest five.

Table 4:
CRITERIA^{a,b} FOR METALS IN SEWAGE SLUDGES

Metals	Anaerobic Sludges		Aerobic Sludges ^b	
	Minimum Ammonium plus Nitrate Nitrogen ($\text{NH}_4^+ - \text{N}$ plus $\text{NO}_3^- - \text{N}$) to Metal Ratios		Maximum Permissible Metal Concentrations (ug/g of solids)	
	Present Requirements	Long-term ^c Targets	Present Requirements	Long-term ^c Targets
ARSENIC	100	480	170	35
CADMIUM	500	4200	34	4
COBALT	50	220	340	77
CHROMIUM	6	32	2800	530
COPPER	10	45	1700	380
MERCURY	1500	8400	11	1.4
MOLYBDENUM	180	1700	94	1.2
NICKEL	40	210	420	80
LEAD	15	75	1100	220
SELENIUM	500	2800	34	6
ZINC	4	20	4200	840

- a. Acceptability will be judged on the basis of the average concentrations of nitrogen, metals and solids during the preceding 12 months or, at the discretion of local MOE staff, on the basis of monthly results over the preceding 3 months.
- b. All dewatered and dried sludges must meet the appropriate sludge criteria before dewatering and drying.
- c. The addition of sludge of low metals content, to soil of mean metals content (see Table 3, column 2) will result in maximum permissible metal concentrations after 250 years. For other soils, the figures will require adjustment.

**Table 5:
MINIMUM DISTANCES TO WATERCOURSES¹**

Maximum Sustained Slope	Soil Permeability²	Distance³ (metres)
0 - 3 %	Rapid to Moderately Rapid Moderate to Slow	50 ⁴ 100 ⁴
3 - 6 %	Rapid to Moderately Rapid Moderate to Slow	100 200
6 - 9 %	Rapid to Moderately Rapid Moderate to Slow	150 Not Permitted
> 9 %	All Permeabilities	Not Permitted
<p>Notes:</p> <ol style="list-style-type: none"> 1. For complete information, refer to Section 5.1.1 2. Determine soil permeability in accordance with OMAF's 'Drainage Guide for Ontario'. Determine the soil type from County Soil Maps, also obtainable from OMAF. 3. Suspend spreading when run-off is expected. 4. Spreading is not normally permitted when soils are frozen. For additional comment, see Section 5.2.6. 		

**Table 6:
OTHER SEPARATION DISTANCES***

Feature	Distance (metres)	Notes
Water Table	0.9	Measured vertically
Bedrock	1.5	Measured vertically
Drilled wells more than 15 m deep	15*	Measured horizontally
All other wells including dug wells	90*	Measured horizontally
Individual residences	90*	Measured horizontally
Residential areas	450*	Measured horizontally
* For circumstances in which distances may be reduced, and for full information, refer to Section 5.1.		

APPENDIX I: SEWAGE SLUDGE APPLICATION

PART A - Average Nutrient Content per Cubic Metre

To be completed by Sewage Treatment Plant Operator

Sewage Treatment Plant(s) _____

Storage Site _____

Nitrogen (as ammonia plus nitrates) _____ /cubic metre

Total Phosphorus _____ kg/cubic metre

Operator's signature _____

PART B - Site and Sludge Source and Quantity Data

To be completed by Sludge Hauler

Farm Operator: _____ Date: _____

Site: _____ Field: _____

Area Covered: _____ (Hectares)

Total Sludge Applied: _____ (Cubic Metres)

Application Method: _____

Hauler's signature _____

PART C - Comments

Conversion Factors

1 kg = 2.2 lb;

1 cubic metre = 220 gallons;

1 hectare = 2.5 acres;

1 mg/l = .001 kg/cubic metre

APPENDIX II: METALS OF CONCERN IN ONTARIO SOILS: A SYNOPSIS OF BACKGROUND INFORMATION

Metals in Ontario Sludges

Metals concentrations in Ontario sewage sludges vary widely. Metals such as Cu (copper), Mo (molybdenum) and Zn (zinc) are required by both plants and animals; in addition, Co (cobalt), Cr (chromium) and Se (selenium) are required by animals. All of these elements, along with As (arsenic), Cd (cadmium), Hg (mercury), Ni (nickel) and Pb (lead) can be toxic to plants or animals, or to both, at certain concentrations. The concentrations at which toxicity commences vary from soil to soil and have not been firmly established. Metals such as copper, zinc, selenium and cobalt, should be widely distributed and not concentrated on a few fields or farms. Others such as copper, zinc, selenium and cobalt, should be widely distributed and not concentrated on a few fields or farms. Other metals such as Ag (silver), Au (gold), Be (beryllium), Bi (bismuth), Pt (platinum), Sb (antimony), Sn (tin), Te (tellurium) and Ti (titanium) may also cause toxicities in plants and animals. However, research has indicated that these metals are unlikely to cause problems when sludge is used under Ontario conditions.

When metals have entered the soil they leach very little. Field crops normally remove less than 0.4 kg. per hectare per year of any of the toxic metals from the soil. Thus, to prevent toxic effects, excessive soil metal concentrations must not be allowed to build up. These Guidelines include criteria to guard against metals building up to toxic concentrations in soils.

Acceptable Accumulations of Metals in Soil

Average metal concentrations in Ontario soils have been determined. Metal uptake into growing plants has not been closely correlated with total metal concentrations in soils. Metal uptake depends upon variable factors such as the crop grown, soil pH, soil organic matter and clay content, soil aeration and the concentrations of nutrients and metals. Consequently, over a period of years, uptake rates do not remain constant.

The total metal concentration in the plough layer seems, at this time, to be the most appropriate criterion for establishing limits for metal additions to soils. The maximum recommended metal concentrations in Ontario soils (see Table 3) are based on the judgment of several people familiar with literature on metals. These recommendations take into account average metal concentrations in Ontario soils and other criteria as follows:

a. Arsenic and Nickel

Recommended maxima were set at twice the Ontario averages because of the known toxic effects on plants.

b. Cadmium

The recommended maximum was set at twice the Ontario average because cadmium's availability to plants is greater than that of other metals and because humans and animals have a low cadmium tolerance.

c. Cobalt, Copper, Selenium and Zinc

Because some Ontario feed crops are deficient in these metals, recommended maxima were set at four times the Ontario averages, to allow for some soil buildup. Copper and zinc are toxic to plants at high concentrations and selenium has a narrow acceptable range in animal feeds.

d. Chromium, Mercury and Lead

These metals are toxic to animals and humans and are not required by plants. Plants take up these metals less readily than other metals. Therefore, the Guidelines permit higher concentrations of these metals relative to the average content of Ontario soils, than of other metals. Although chromium is not required by plants, it has been found to be essential for animals and it may be deficient in human food.

e. Molybdenum

The recommended level of accumulation was set at twice the Ontario average because molybdenum leaches more from well-drained soils than do other metals. On one recorded occasion, molybdenum caused toxicity problems for Ontario livestock.

f. Aluminum, Boron, Calcium, Iron, Magnesium, Manganese, Potassium, Sodium and Sulphur

No recommendations have been made, because sludge application is not expected to cause concentrations to become critical under Ontario conditions.

APPENDIX III: REFERENCE PUBLICATIONS

A. Relevant Legislation

Copies of legislation may be obtained from the Ministry of Government Services, 880 Bay Street, Toronto, Ontario M5S 1Z8. The Ontario Government Bookstore (first floor - tel: 416-326-5300) handles both direct sales and mail orders.

The Ontario Water Resources Act

This Act provides for the control and protection of quality and quantity of surface and ground waters. It is administered by the Ministry of the Environment.

The Environmental Protection Act

This Act prohibits the contamination of the natural environment and provides for environment preservation and improvement. It is administered by the Ministry of the Environment. Ontario Regulation 309, which establishes standards for waste disposal and utilization sites, is issued pursuant to this Act.

The Environmental Assessment Act

This Act provides for the environmental assessment of undertakings carried out by provincial and municipal agencies. It is administered by the Ministry of the Environment.

The Planning Act

This Act provides for orderly planning of the development and use of lands in the province. It is administered by the Ministry of Municipal Affairs.

B. OMAF Publications

Copies of these documents may be obtained from the OMAF offices listed in Appendix IV.

Publication 29: Drainage Guide for Ontario

Publication 296: Field Crop Recommendation

Publication 360: Fruit Crop Recommendation

Fact Sheet AGDEX 100/541: How and Where to Use Sewage Sludge in Crop Production

C. Other Publications

Guidelines to Govern the Stabilization and/or Dewatering of Municipal Sewage Sludge Prior to Its Utilization/Disposal

These Guidelines may be obtained from the Ministry of the Environment, Water Resources Branch, 1 St. Clair Avenue West, Toronto, Ontario M4V 1K6 (Tel: 416-323-4941)

MOE Fact Sheet: About Sewage Sludge in Agriculture

Obtainable from MOE's Public Affairs and Communications Services Branch in Toronto (Tel: 416-323-4663) and MOE Regional and District Offices.

MOE Class Environmental Assessment Document - Expansion or Upgrading of an Existing Sewage of Water System

Contains criteria for changes to sludge systems, such as new or changed sludge disposal methods, and the establishment of sludge storage for MOE Sewage Treatment Plans.

Class Environmental Assessments for Municipal Sewage and Water Projects

Contains criteria as above, but for Municipal Sewage Treatment Plants.

APPENDIX IV: MINISTRY OF AGRICULTURE AND FOOD OFFICES

County/District	Telephone No. (Fax No. in brackets)	Address
Algoma	705 253-1161 (705 253-8777)	Heritage Corner 341 Trunk Road Sault Ste. Marie P6A 3S9
Brant	519 759-4190 (519 759-6857)	Unit 7, 515 Park Rd.N. Brantford M3R 7K6
Bruce	519.881-3301 (519 881-2739)	220 Trillium Court, R.R.#3 Walkerton N0G 2V0
Carleton	613 828-9167 (613 828-6083)	26 Thorncliffe Pl. Nepean K2H 6L2
Cochrane N.	705 335-5828 (705 337-6597)	Experimental Farm West Riverside St. Highway #11 Kapuskasing P5N 2X9
Cochrane S.	705 273-2509 (705 273-2967)	Box 608, 4th Avenue Matheson P0K 1N0
Dufferin	519 941-3830 (519 941-5689)	R.R.4, Mono Plaza Highway #10 North Orangeville L9W 2Z1
Dundas	613 774-2313 (613 774-3283)	Box 488, 457 Main Winchester K0C 2K0
Durham Region	416 985-2003 (416 985-9599)	60 Van Edward Dr. Port Perry L9I 1G3
Elgin	519 631-4700 (519 631-8784)	Box 2027, RR#5 County Road 45 St. Thomas N5P 3X1
Essex	519 776-7361 (519 776-8028)	46 Fox St. Essex N8M 2S2
Frontenac	613 545-4360 (613 545-9147)	Box 651, 1055 Princess St. Kingston K7L 4X1

County/District	Telephone No. (Fax No. in brackets)	Address
Glengarry	613 258-8295 (613 525-2457)	Box 579, Main St. & George St. East Alexandria K0C 1A0
Grenville	613 258-8295 (613 258-8392)	Box 2004, Provincial Govt. Bldg. Concession Rd. Kemptonville K0G 1J0
Grey	519 986-2040 (519 986-3014)	181 Toronto St. South Markdale N0C 1H0
Haldimand	416 772-03381 (416 772-3957)	Box 129, Cayuga St., 2nd Floor Cayuga N0A 1E0
Halton/Peel	416 873-9930 (416 873-9934)	332 Guelph St. Georgetown L7G 4B5
Hastings	613 395-3393 (613 258-0739)	Box 340, 234 North St. Stirling K0K 3E0
Huron	519 482-3428 (519 482-5031)	Box 159, 100 Don St. Clinton N0M 1L0
Kenora	807 223-2415 (807 223-2824)	Ontario Govt. Bldg. 479 Government St., Box 3000 Dryden P8N 3B3
Kent	519 354-22150 (519 354-8842)	Box 726, 435 Grand Ave. W. Chatham N7M 5L1
Lambton	519 882-0180 (519 882-3406)	Box 730, 360 Highway #21 Petrolia N0N 1R0
Lanark	613 267-1063 (613 267-2264)	10 Sunset Blvd. Perth K7H 2Y2
Leeds	613 342-2124 (613 342-1886)	Box 635, 333 California Unit 15 Brockville K6V 5H8
Lennox & Addington	613 354-3371 (613 354-3267)	41 Dundas St. W Napanea K7R 1Z5
Manitoulin	705 282-2043 (705 282-2792)	Box 328, Meridith Eleanor Sts. Gore Bay P0P 1H0

County/District	Telephone No. (Fax No. in brackets)	Address
Middlesex	519 434-6811 (519 434-4627)	50 King St. London N6A 2P2
Muskoka	705 789-8886 (705 789-1241)	Box 130, 8 Centre St. N. Huntsville P0A 1K0
Niagara - Vineland	416 562-4147	Advisory Services Building Victoria Ave. N. Vineland Station L0R 2E0
Niagara - Fenwick	416 892-4741 (416 892-1472)	726 Canboro Rd. Fenwick L0S 1C0
Nipissing	705 474-3050 (705 472-0882)	222 McIntyre St. W. North Bay P1B 2Y8
Norfolk	519 426-7120 (519 428-1142)	Box 587 Agricultural Building, Blue Line Rd. Simcoe N3Y 4N5
Northumberland	613 475-1630 (613 475-3835)	Box 8200, 95 Dundas St. Brighton K0K 1H0
Oxford	519 537-6621 (519 539-5351)	Box 666, Oxford Regional Centre Highway #59 North Woodstock N4S 7Z5
Perth	519 271-0280 (519 273-5278)	413 Hibernia St. Stratford N5A 5W2
Peterborough	705 745-2403 (705 745-6657)	55 George St. N. Peterborough K9J 3G2
Prescott	613 673-5115 (613 673-5578)	Box 110, Highway #178 Main St. Plantagenet K0B 1L0
Prince Edward	613 476-3224 (613 476-3370)	Box 470, Highway #33 West Picton K0K 2T0
Rainy River	807 482-2310 (807 482-2864)	Box 210, Front St. Rainy River P0W 1E0
Renfrew	613 432-4841 (613 432-7845)	315 Raglan St. S. Renfrew K7V 1R6

County/District	Telephone No. (Fax No. in brackets)	Address
Russell	613 443-3391 (613 443-5082)	735 Rue Notre Dame Embrun KOA 1W1
Simcoe N.	705 322-2231 (705 322-0740)	Box 340, 144 Yonge St. S. Elmvale LOL 1P0
Simcoe N.	705 322-2231 (705 435-5428)	Box 340, 144 Yonge St. S. Alliston L9M 1A0
Stormont	613 346-2143 (613 346-2689)	Box 97, Centennial Drive Avonmore K0C 1C0
Sudbury	705 566-1630 (705 566-8166)	1899 LaSalle Blvd. Sudbury P3A 2A3
Thunder Bay	807 475-1631 (807 475-1219)	Ontario Govt. Bldg. 435 James St. S. Thunder Bay P7E 6E3
Timiskaming	705 647-6701 (705 647-6297)	Box G, New Liskeard College of Agricultural Technology Highway #11B North New Liskeard, POJ 1P0
Victoria	705 324-6125 (705 324-1638)	322 Kent St. W. Lindsay K9V 2Z9
Waterloo	519 884-5390 (519 884-0241)	279 Weber St. N. Waterloo N2J 3H8
Wellington	519 846-0941 (519 846-8178)	R.R. 1, Wellington Place County Rd. #18 Fergus N1M 2W3
Wentworth	416 527-2995 (416 648-0817)	R.R. 1, 617 Highway #53 East Ancaster L9G 3K9
York	416 895-4519 (416 895-6739)	1110 Stellar Drive Newmarket L3Y 7B7

APPENDIX V: MINISTRY OF THE ENVIRONMENT OFFICES

SOUTHWESTERN REGION

London (519-661-2200; Fax 519-661-1742)
985 Adelaide St. S. N6E 1V3

Owen Sound (519-371-2901; Fax 519-371-2905)
1180 20th St. E. N4K 6H6

Sarnia (519-336-4030; Fax 519-336-4280)
Suite 109, 265 Front St. N. N7T 7X1

Windsor (519-254-2546; Fax 519-254-5894)
6th Floor, 250 Windsor Ave. N9A 6V9

WEST CENTRAL REGION

Cambridge (519-653-1511; Fax 519-622-3119)
Box 219, 400 Clyde Rd. L8N 3Z9

Hamilton (416-521-7640; Fax 416-521-1601)
12th Floor, 199 King St. W., Box 2112, L8N 3Z9

Welland 9416-735-0431; Fax 416- 735-0574)
637-641 Niagara St. N. L3C 1L9

CENTRAL REGION

Barrie (705-726-1730; Fax 705-726-5100)
12 Fairview Rd. L4N 4P3

Gravenhurst (705-687-6647; Fax 705-687-3715)
483 Bethune Dr. P0C1G0

Oakville 416-844-5747; Fax 416 842-1750)
Suite 401, 1235 Trafalgar Road L6H 3P1

Peterborough (705-748-2972; Fax 705-748 4192)
139 George St. N. K9J 3G6

Toronto (416-424-3000; Fax 416-963-2935)
7, Overlea Blvd. 4th Floor M4H 1A8

SOUTHEASTERN REGION

Belleville (613-962-9208; Fax 613-962-6809)
470 Dundas St. E. K8N 1Z5

Cornwall (613-933-7402; Fax 613-933-6402)
205 Amelia St. K6H 3P3

Kingston (613-549-4000; Fax 613- 548-6908)
Box 820, 133 Dalton, Ave. K7L 4X6

Ottawa (613-521-3450; Fax 613-521-5437)
2nd Floor, 2435 Holly Lane, K1V 7P2

Pembroke (613-732-3643; Fax 613-732-2668)
1000 MacKay St. K8B 1A3

NORTHEASTERN REGION

North Bay (705-746-1001; Fax 705-476-0207)
Northgate Plaza, 1500 Fisher St. P1B 2H3

Parry Sound (705-746-2139; Fax 705-746-2011)
74 Church St. P2A 1Z1

Sault Ste. Marie (705-949-4640; Fax 705-949
4642) 445 Albert St. E. P6A 2J9

Sudbury (705-675-4501; Fax 705-675-4180)
11th Floor, 199 Larch St. P3E 5P9

Timmins (705-268-3222; Fax 705-264-7336)
83 Algonquin Blvd. W. P4N 2R4

NORTHWESTERN REGION

Kenora (807-468-2725; Fax 807-468-2735)
Box 5150, 808 Robertson St. P9N 1X9

Thunder Bay (807-475-1205; Fax 807-475-1754)
Box 5000, 435 James St. W. 3rd. Floor P7C 5G6

NOTES

NOTES

FACTORS FOR CONVERSION OF METRIC UNITS TO IMPERIAL UNITS

Metric Units	Approximate Conversion Factor	Imperial Units
Linear		
centimetre (cm)	x 0.39	inch
metre (m)	x 1.1	yard
kilometre (m)	x 0.62	mile
Area		
hectare (ha)	x 2.5	acre
Volume		
cubic metre (m ³)	x 1.3	cubic yard
litre (l)	x 0.22	gallon
Weight		
Kilogram (kg)	x 0.45	pound
Application of Units		
cubic metres per hectare (m ³ /ha)	x 89	gallons per hectare
tonnes per hectare (t/ha)	x 0.45	tons per acre
kilograms per hectare (kg/ha)	x 0.89	pounds per acre

